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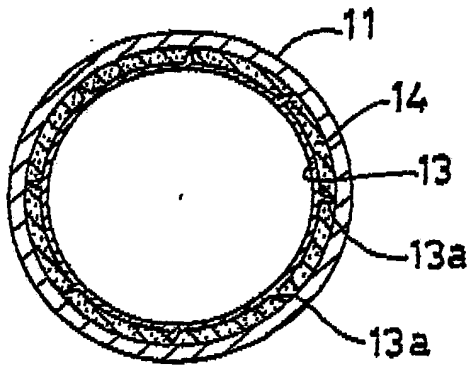

(57) Abstract

A method for the production of composite pipes that have an inner pipe made of synthetic resin and an outer pipe made of metal, the inner surface of which is lined with the inner pipe. Said method comprising applying a foaming adhesive to the inner surface of an outer pipe, introducing an inner pipe made of synthetic resin into the outer pipe, and heating the foaming adhesive to foam and harden the foaming adhesive, wherein said inner pipe has, on its outer surface, a number of lines projecting from the inner pipe that are parallel with the axis of the pipe, said lines being of fixed length and discontinuous so that said inner pipe can be concentric with the outer pipe when it is introduced into the outer pipe.

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A METHOD FOR THE PRODUCTION OF COMPOSITE PIPES

Field of the Invention

This invention relates to a method for the production of composite pipes that have an inner pipe made of synthetic resin and an outer pipe made of metal, for example, steel, etc., the inner surface of which is lined with the inner pipe. More particularly, this invention relates to a method for the production of composite pipes in which the outer pipe and the inner pipe adhere to each other to make one piece by means of a foamed layer.

Background Art

The following methods are known for the method of manufacturing a composite pipe that consists of a metal outside pipe made of steel, etc., the inner surface of which is lined with an inner pipe made of synthetic resin. First, a foaming adhesive is applied either to the inner surface of the outer pipe made of metal, to the outer surface of the inner pipe made of synthetic resin, or to both of these surfaces. Then, the inner pipe is introduced into the outer pipe, and the foaming adhesive is foamed and hardened by the addition of heat. In this way, by means of the bubbles of the foaming adhesive, which forms a foamed layer between the inner surface of the outer pipe and the outer surface of the inner pipe, a composite pipe that adheres together in one piece is obtained.

In this kind of method, it is difficult to introduce the inner pipe into the outer pipe so that they will be concentric. Also, even if the inner pipe can be introduced into the outer pipe so that the pipes

are concentric, the foaming of the foaming adhesive between the inner pipe and the outer pipe can cause the centers to coincide no longer, and there is the possibility that the space between the inner surface of the outer pipe and the outer surface of the inner pipe will not be uniform in the radial direction of the pipes.

A method for the manufacture of composite pipes that overcomes these disadvantages has been disclosed in Japanese Patent Publication (KOKOKU) 59-49885, wherein an inner pipe the outer surface of which has a number of projecting lines that are continuous and parallel in the direction of the axis of the pipe is used. The distance by which each of these projecting lines project from the outer surface of the inner pipe is the same. Therefore, when the inner pipe is introduced into the outer pipe, the projecting lines of the outer surface of the inner pipe come into contact with the inner surface of the outer pipe, and the outer pipe and the inner pipe are held against each other so as to be concentric. Each projecting line is in contact with the inner surface of the outer pipe, so even when the foaming adhesive in the space between the outer pipe and the inner pipe is foamed the concentricity of the outer pipe and the inner pipe can be maintained.

However, when the foaming adhesive is applied to the inner surface of the outer pipe, and the inner pipe that has projecting lines on its outer surface is introduced into said outer pipe, one or more of the projecting lines on the outer surface of the inner pipe comes into contact with the foaming adhesive that has

been applied onto the inner surface of the outer pipe, and this causes the application of pressure to the inner pipe. For this reason, it is not easy to introduce the inner pipe into the outer pipe. When a pipe made of a thin layer of synthetic resin is used as the inner pipe, then said inner pipe is deformed by being curved or twisted, etc., by the pressure that is applied to the inner pipe at the time of the introduction of the inner pipe into the outer pipe. When the inner pipe is deformed, then this inner pipe is not introduced into the outer pipe so that the pipes are concentric, but rather the inner pipe will be introduced into the outer pipe so that it is bent toward the outer pipe in one direction or a zigzag direction. In these circumstances, the lines projecting from the outer surface of the inner pipe come strongly into contact with the inner surface of the outer pipe. If the lines projecting from the outer surface of the inner pipe come into strong contact with the inner surface of the outer pipe, said projecting lines will scrape away the foaming adhesive applied to the inner surface of the outer pipe. If the inner pipe is twisted, a large number of projecting lines over a wide area will come into contact with the inner surface of the outer pipe, and a large area of the foaming adhesive on the inner surface of the outer pipe will be scraped away. The consequences are that there will be an area of the inner surface of the outer pipe where the lines projecting from the outer surface of the inner pipe have scraped away the foaming adhesive, and also other areas where the adhesive that has been scraped away has accumulated. In this situation, then the foaming adhesive that has been applied to the inner surface of the outer pipe is foamed and hardened by the

addition of heat, a gap forms in the space between the inner pipe and the outer pipe in the places where the adhesive has been scraped away from the inner surface of the outer pipe. If water is introduced into the said gap, the outer pipe made of metal will corrode. If the composite pipe is used for the flow of relatively hot water, softening of the inner pipe made of synthetic resin will occur and the gap between the inner pipe and the outer pipe will expand in volume, and accordingly the inner pipe will expand inward, resulting in the constriction of the space for the passage of flowing water. Thus, if the expansion of the inner pipe is severe, the passage for flowing water will be blocked. The possibility of expansion of the inner pipe inward is particularly high when the temperature difference of the water flowing through it at different times is large. If the inner pipe is made thick, there will not be any deformation of the inner pipe when it is introduced into the outer pipe, and this prevents the occurrence of gaps between the inner pipe and outer pipe. However, a thick inner pipe is not economical.

Disclosure of the Invention

The method for the production of composite pipes of this invention, which overcomes the above-discussed and numerous other disadvantages and deficiencies of the prior art, comprises applying a foaming adhesive to the inner surface of an outer pipe, introducing an inner pipe made of synthetic resin into the outer pipe, and heating the foaming adhesive to foam and harden the foaming adhesive, wherein said

inner pipe has, on its outer surface, a number of lines projecting from the inner pipe that are parallel with the axis of the pipe, said lines being of fixed length and discontinuous so that said inner pipe can be concentric with the outer pipe when it is introduced into the outer pipe.

In a preferred embodiment, the length of the projecting lines is about 1-10 mm in the direction of the axis of the pipe, the space between the adjacent projecting lines positioned in a line in the direction of the axis of the pipe is about 10-100 mm, and the space between adjacent projecting lines positioned in a row in the direction of the circumference of the pipe is about 10-30 mm.

Thus, the invention described herein makes possible the objectives of (1) providing a method for the production of composite pipes in which even when the inner pipe made of synthetic resin has a thin wall, little pressure is applied to the inner pipe when the inner pipe is being introduced into the outer pipe, and there is almost no chance that the inner pipe will be deformed, and therefore, there is almost no possibility that the lines projecting from the outer surface of the inner pipe will scrape away the adhesive that has been applied to the inner pipe; (2) providing a method for the production of composite pipes in which when the inner pipe is introduced into the outer pipe, even if said inner pipe is twisted, the area of the adhesive that is scraped away from the inside surface of the outer pipe is extremely small, because the projecting lines are not continuous; therefore, even if the amount of adhesive on different parts of the inner surface of

the outer pipe is slightly uneven, when the foaming adhesive is foamed and hardened after the inner pipe is introduced into the outer pipe, the gaps between the inner pipe and the outer pipe will be filled with bubbles because of the foaming pressure at the time of foaming; (3) providing a method for the production of composite pipes by which the bubbles ensure that gaps will not occur in the space between the inner pipe and the outer pipe, but rather that the two pipes will be made to adhere to each other strongly, so that the composite pipe obtained will not allow water to move into the space between the inner pipe and the outer pipe; accordingly, there is no danger of corrosion of the inner surface of the outer pipe; and (4) providing a method for the production of composite pipes by which even if hot water and cold water are alternately sent to flow through the inside of said composite pipe, the inner pipe of synthetic resin will not expand inward, so there is no danger of the passageway for water inside said inner pipe becoming narrow or of the blockage of said inner pipe.

Brief Description of the Drawings

This invention may be better understood and its numerous objects and advantages will become apparent to those skilled in the art by reference to the accompanying drawings as follows:

Figure 1 is a side view of an apparatus used to accomplish the method of this invention, Figure 2 is a sectional view of an important part of the apparatus shown in Figure 1, Figure 3 is a front view of the

inner pipe of this invention, Figure 4 is a side view of the inner pipe, and Figures 5 and 6, respectively, are side views of different examples of the inner pipes of this invention. Figure 7 is a front view of the composite pipe manufactured by the method of this invention, and Figure 8 is a side view of one part of that pipe, which has been opened up.

Modes of Carrying Out the Invention

The method of this invention is accomplished by the use of the apparatus shown in Figure 1. An outer pipe 11 made of metal is placed on rollers 21 that are provided on a stand 20, and by the rotation of these rollers 21, the said outer pipe 11 is rotated in the direction of its circumference. Into the outer pipe 11 that is placed on the rollers 21 on the stand 21, a spraying pipe 31 is introduced in the axial direction of the said outer pipe 11. One end of the spraying pipe 31 is placed within the outer pipe 11, and the other end extends to the outside of the outer pipe 11. The end of the spraying pipe 31 that extends to the outside of the outer pipe 11 is coupled by means of a coupling device 33 to the upper surface of a belt conveyor 32 that can move back and forth in the direction shown by arrow A in Figure 1. The belt conveyor 32 is built so that it can move in and out of the outer pipe 11 in the direction of its axis. Because the upper surface of belt conveyor 32 can move back and forth in the direction shown by arrow A in Figure 1, the spraying pipe 31 can move back and forth along the outer pipe 11 in the direction of its axis, from one end of the outer pipe 11 to the other. A

liquid foaming adhesive 12 flows along the inside of the spraying pipe 31. The foaming adhesive 12 that flows through the spraying pipe 31 is, as shown in Figure 2, sprayed in the direction of the circumference of the outer pipe 11 through a nozzle 31a at the top of the spraying pipe 31 placed inside of the pipe 11. In the vicinity of nozzle 31a of the spraying pipe 31, there is provided a position-setting device 34 that maintains the nozzle 31a in a position where it is approximately concentric to the outer pipe 11. On the other hand, in a position opposite to that of the belt conveyor 32 with respect to the stand 20, there is placed an inner pipe 13. The inner pipe 13 is placed on a belt conveyor 40 so that it is lined up with the outer pipe 11 in the direction of its axis. By the movement of the belt conveyor 40 in the direction of the axis of the inner pipe 13, the said pipe 13 is introduced into the outer pipe 11.

There are a number of projecting lines 13a on the outer surface of said inner pipe 13, as shown in Figure 3 and Figure 4. These projecting lines 13a are provided so that, for example, there are six parallel lines in the direction of the axis of the inner pipe 13, placed so as to divide the outer surface of said inner pipe 13 in the direction of its circumference into six equal parts, and they are of a fixed length in the direction of the axis of the pipe, and are not continuous. In cross-section, these lines 13a are in the shape of a triangle. The amount of the projecting lines 13a that projects from the outer surface of the inner pipe 13 is set so as to be approximately equal to the space that is between the inner surface of the outer pipe 11 and the outer

surface of the inner pipe 13 when the inner pipe 13 is placed into the outer pipe 11 so that they are concentric. The length of the projecting lines 13a in the direction of the axis of the pipe 13 should be as short as possible provided that it is possible for them to keep the inner and outer pipes concentric. This length depends on such factors as the thickness of the walls of the inner pipe 13, etc., but it is around 1-10 mm, and preferably 1-5 mm. The space between the adjacent projecting lines 13a positioned in a line in the direction of the axis of the pipe should be as long as possible provided that it is possible for them to keep the inner and outer pipes concentric when the inner pipe 13 is introduced into outer pipe 11. This length depends on such factors as the thickness of the walls of inner pipe 13, etc., but it is around 10-100 mm, and preferably around 30-70 mm. The projecting lines 13a should be formed so that they are parallel with the axis of the inner pipe 13, on its outer surface, and so that they are discontinuously positioned in a plurality of lines. In this case, it is not necessary that lines in which the projecting lines 13a are positioned on the outer surface of the inner pipe be equally spaced in the direction of the circumference of the pipe. This space should be as wide as possible so long as the inner pipe 13 and outer pipe 11 are maintained so as to be concentric; in practice, this space is set to be about 10-30 mm.

The projecting lines 13a need not be in rows around the circumference of the pipe, but may be offset from each other in the direction such as that shown in Figure 5. Alternatively, as shown in Figure 6, the projecting lines 13a may be positioned in a spiral

pattern.

An inner pipe 13 with this kind of projecting lines 13a is manufactured as follows:

An inner pipe 13 is, first, manufactured by an extrusion molding technique from vinyl chloride, polyethylene, or other synthetic resins so that the outer surface of the inner pipe 13 has a number of such projecting lines that are continuous and that are parallel with the long axis of the pipe; then, the parts of the continuous lines that are not needed are removed by cutting working, etc. It is also possible to obtain such an inner pipe 13 by an extrusion molding technique alone, in which an outer mold that has on its inner surface a number of grooves stretching in the direction of the axis of the mold is used; at the time of extrusion, the said outer mold is moved back and forth so as to intermittently have the grooves met with the sprue of the molding apparatus from which molten resin is extruded, resulting in an inner pipe 13 with the projecting lines 13a on its outer surface. Alternatively, while moving this kind of an outer mold back and forth in the direction of its axis, if the mold is also rotated, it is possible to obtain an inner pipe 13 such as that described above by extrusion molding alone.

The method of this invention with the use of this kind of the inner pipe 13 can be practiced as follows:

First, an outer pipe 11 is placed on the rollers 21 on the stand 20. Next, the spraying pipe 31 is driven by the belt conveyor 32 so as to be introduced into the outer pipe 11 on the rollers 21. Then, the nozzle 31a of the spraying pipe 31 is placed inside of one end of the outer pipe 11. While the rollers 21 are being rotated so as to rotate the outer pipe 11 around the axis of the pipe 11, the foaming adhesive 12 is sprayed from the nozzle 31a. The foaming adhesive 12 is composed of resins such as urethane resins, epoxy resins, polyester resins, etc., and, as a foaming agent, hydrocarbons such as freon, hexane, heptane, etc., or water. While foaming adhesive 12 is being sprayed from the nozzle 31a of the spraying pipe 31, it is moved in the direction of the axis of the outer pipe 11 by means of the belt conveyor 32. In this way, the inner surface of the outer pipe 11 is coated with the foaming adhesive 12 from one end of the pipe to the other. At this time, the outer pipe 11 is being rotated, so there is no danger that the foaming adhesive 12 being applied to the inner surface of the outer pipe will drip.

After the foaming adhesive 12 has been coated over the inner surface of the outer pipe 11, and before the said foaming adhesive is foamed and hardened, the inner pipe 13 made of synthetic resin that is placed on the belt conveyor 40 is driven by the belt conveyor 40 so as to be introduced into the outer pipe 11. At that time, as described above, because there are projecting lines 13a on the outer surface of the inner pipe 13 that are not continuous in the direction of the axis of the inner pipe 13, it is possible to introduce the inner pipe 13 accurately into the outer pipe 11 so that

the two pipes are concentric. Moreover, the amount of the foaming adhesive 12 that has been applied to the inner surface of the outer pipe 11 scraped off by the projecting lines 13a is small, and there is no chance of the maldistribution of foaming adhesive 12 on the inside surface of the outer pipe 11.

When the inner pipe 13 is introduced into the outer pipe 11, hot water is then poured over the outside of the outer pipe 11, whereby the foaming adhesive 12 in the space between the outer pipe 11 and the inner pipe 13 is heated, causing the foaming and hardening of the said foaming adhesive. At this time, in order that gaps will not form in the foamed layer that forms when the foaming adhesive 12 is foamed and hardened, hot water is poured over the outside of the outer pipe 11 either from one end of the pipe to the other or else from the middle to both ends at once. In this way, the air in the space between the outer pipe 11 and the inner pipe 13 is moved to the ends of the outer pipe 11 as the foaming adhesive is foamed, so that the air leaves the ends of outer pipe 11.

By doing this, a composite pipe, as shown in Figures 7 and 8, which has the outer pipe 11 and the inner pipe 13 that are made to strongly adhere to each other by the foaming layer 14, can be obtained.

It is possible to decide on the amount of foaming adhesive 12 that is needed for the application to the inner surface of the outer pipe 11 so that by its foaming, the foaming layer 14 will cause sufficient adhesion of the inner pipe 13 to the outer pipe 11. The amount varies depending on the volume of the space

between the inner pipe 13 and the outer pipe 11, and also on the foaming ratio of the adhesive, but it is preferable that the amount of foaming adhesive to be used be twice or more than the volume between the outer pipe 11 and the inner pipe 13 when the foaming adhesive 12 is allowed to form bubbles freely. The foaming adhesive 12 can be also coated on the outer surface of the inner pipe 13 in addition to the application of the foaming adhesive 12 to the inner surface of the outer pipe 11.

Example

As the outer pipe, a steel pipe with the outer diameter of 110 mm, the inner diameter of 106 mm, and the length of 5 m was used; as the inner pipe, a hard vinyl chloride pipe with an outer diameter of 104 mm, an inner diameter of 100 mm, and a length of 5 m was used. On the outer surface of the inner pipe, there were projecting lines that were not continuous, which were 3 mm long in the direction of the axis of the pipe, 1 mm high, and triangular in cross-section; these projecting lines were 50 mm apart in the direction of the axis of the pipe. These projecting lines were positioned in 16 lines parallel to the axis of the pipe. The distance between the adjacent lines in the direction of the circumference was 20.4 mm.

As the foaming adhesive, semi-hard urethane resin liquid was used. The ingredients of this liquid were in the following proportions, by weight.

Diol (OH value, 28)	100
Ethylene glycol	15
Triethylenediamine	0.6

Silicone as an agent for regulation of foaming	2.0
Water	2.0
Gurudo (phonetic) MDI (Trade name; NCO index 105)	90
Pigment (special polyester resin containing 25% carbon black by weight)	2.0

When this liquid was allowed to foam freely, it foamed to about 10 times its original volume, and the independent foaming ratio was 33%.

This foaming liquid was coated over the inner surface of the outer pipe made of metal to a thickness of about 0.35 mm. The application was done by the use of the apparatus described above in which the adhesive was sprayed from the spraying pipe 31. After the application, the inner pipe made of synthetic resin that had non-continuous projections was immediately introduced into the outer pipe 11. At this time, resistance to the introduction of the inner pipe was low, and introduction into the outer pipe was smooth, without the inner pipe zigzagging or becoming twisted. When the inner pipe had been inserted, it and the outer pipe were concentric, and the space between the two pipes was uniform in the direction of the radiuses of the pipes. After the inner pipe had been introduced into the outer pipe in this way, hot water was poured over the outside of the outer pipe from the center to both ends of the pipe, whereby the foaming adhesive was heated from the outside of the pipe, which caused the foaming and hardening of the foaming adhesive.

When the composite pipe obtained in this way was cut cross-sectionally in a number of places, the inner pipe made of synthetic resin was seen to be adhering strongly to the outer pipe made of metal because of the foaming layer, which was of uniform thickness everywhere. There were no gaps at all detected in the foaming layer. When hot water at 85°C and cold water at 20°C was alternately and repeatedly sent to flow through the pipe, there was no expansion of the inner surface of the inner pipe made of synthetic resin toward the inside of the pipe.

It is understood that various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be construed as encompassing all the features of patentable novelty that reside in the present invention, including all features that would be treated as equivalents thereof by those skilled in the art to which this invention pertains.

Claims

1. A method for the production of composite pipes comprising applying a foaming adhesive to the inner surface of an outer pipe, introducing an inner pipe made of synthetic resin into the outer pipe, and heating the foaming adhesive to foam and harden the foaming adhesive, wherein said inner pipe has, on its outer surface, a number of lines projecting from the inner pipe that are parallel with the axis of the pipe, said lines being of fixed length and discontinuous so that said inner pipe can be concentric with the outer pipe when it is introduced into the outer pipe.

2. A method for the production of composite pipes according to claim 1, wherein the length of the projecting lines is about 1-10 mm in the direction of the axis of the pipe, the space between the adjacent projecting lines positioned in a line in the direction of the axis of the pipe is about 10-100 mm, and the space between adjacent projecting lines positioned in a row in the direction of the circumference of the pipe is about 10-30 mm.

Fig. 1

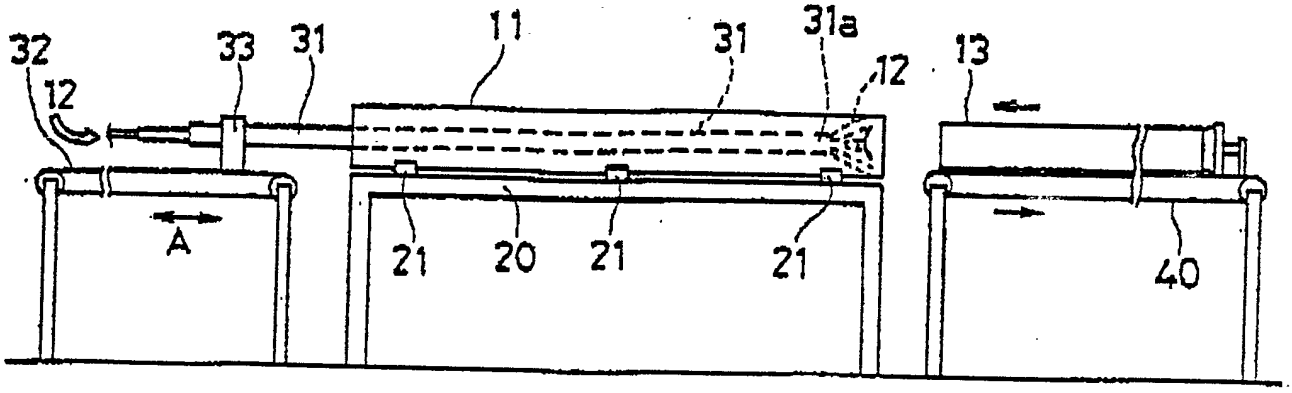


Fig. 2

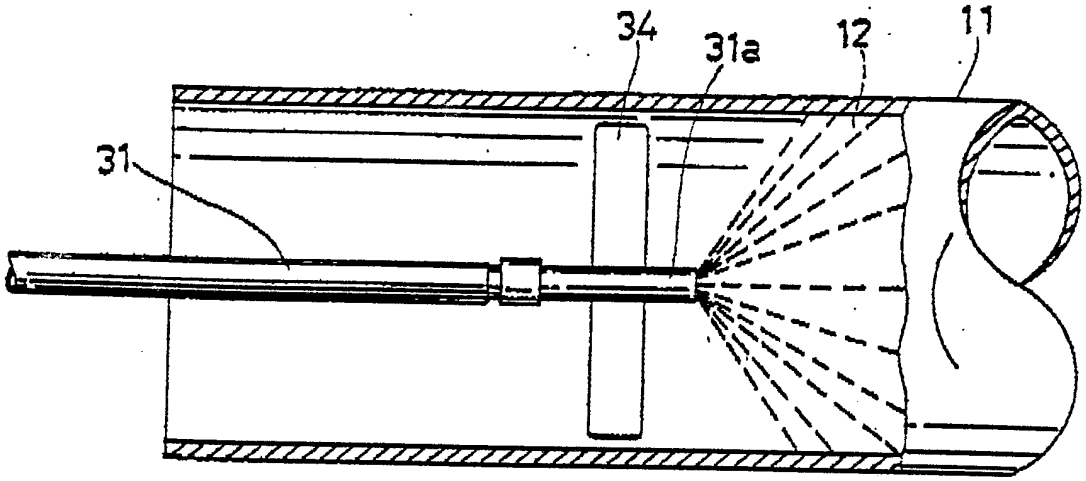


Fig. 3

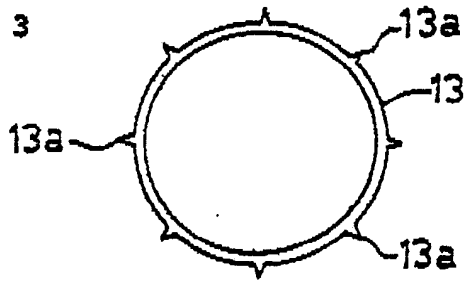


Fig. 4

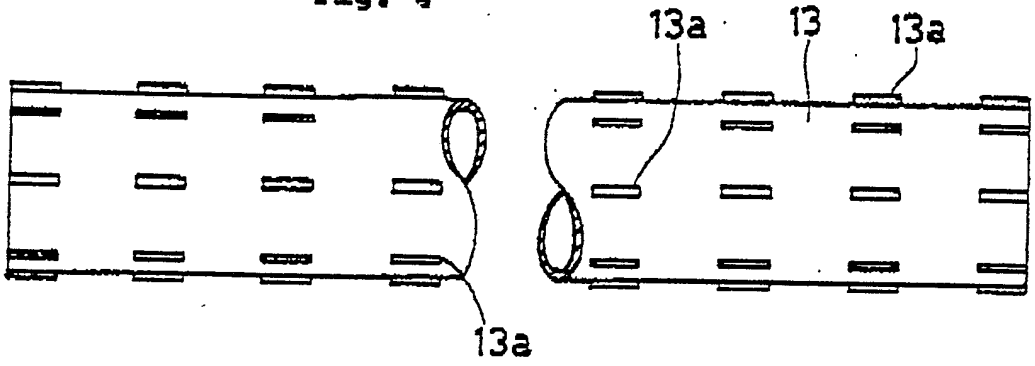


Fig. 5

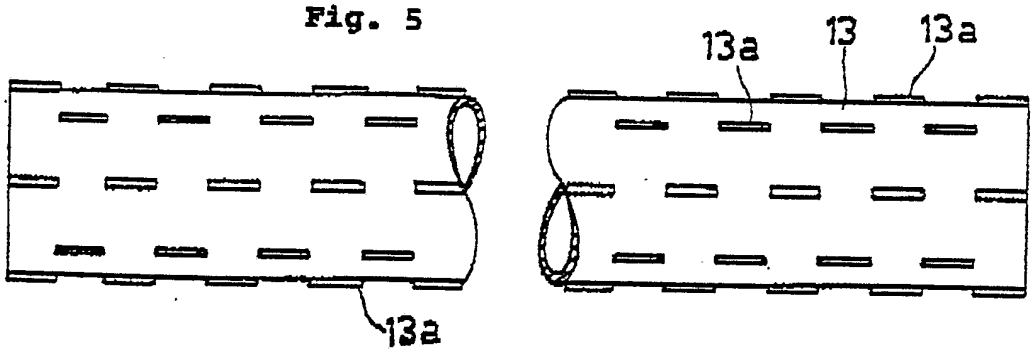


Fig. 6

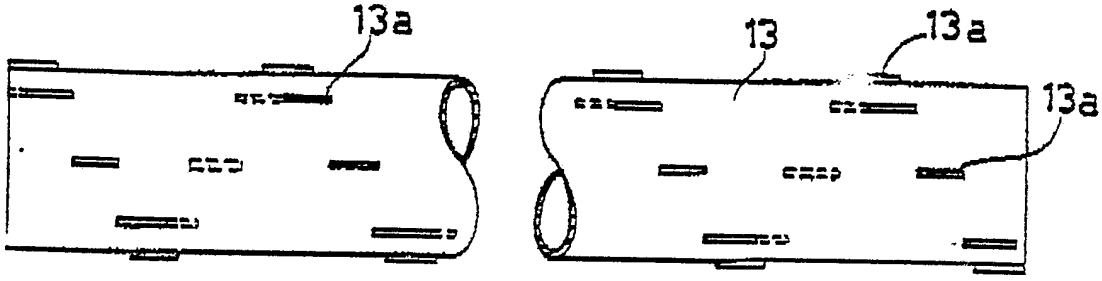


Fig. 7

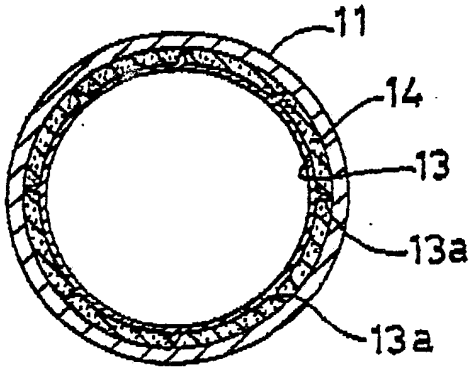
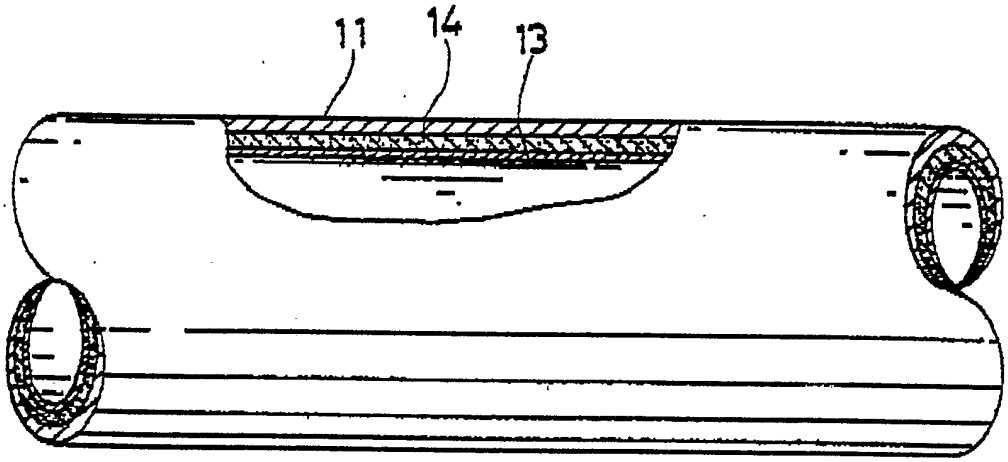


Fig. 8



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP 88/00029

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: B 29 C 67/22

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	B 29 C; F 16 L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	FR, A, 2479945 (CHAUDRONNERIE TUYAUTERIE DE BRANGUES CTB) 9 October 1981 see figure 3	1,2
X	GB, A, 1083185 (A. MEIER-SCHENK) 13 September 1967 see figures 1,3; page 2, lines 76-120	1,2
A	DE, A, 3315819 (KAPER) 31 October 1984 see figure 4	1
A	DE, B, 1265517 (ETERNIT) 4 April 1968 see figures 1,2	1

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
19th September 1988	- 7 OCT 1988
International Searching Authority: EUROPEAN PATENT OFFICE	Signature of Authorized Officer: P.C.G. VAN DER PUTTEN

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. JP 8800029 SA 20277

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 29/09/88
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A- 2479945	09-10-81	US-A- 4384905	24-05-83
GB-A- 1083185		NL-A- 6406964	01-03-65
		BE-A- 650478	03-11-64
		GB-A- 1083186	
DE-A- 3315819	31-10-84	None	
DE-B- 1265517		NL-A- 6612606	21-03-67
		BE-A- 685357	16-01-67
		CH-A- 456276	
		FR-A- 1492688	